Docket No. 5024

MANUAL/AUTOMATIC PRESSURE CONTROL MECHANISM FOR CENTRIFUGAL CLUTCH

Cross-Reference to Related Applications

This application is a continuation-in-part of patent application Serial No. 09/877,518, filed 7 June, 2001 for AUTOMATIC CLUTCH WITH MANUAL OVERRIDE CONTROL MECHANISM and Application Serial No. 10/327,160, filed 20 December, 2002 for MULTI-ROW CAM-ACTUATED CENTRIFUGAL CLUTCH, both applications by Douglas W. Drussel and George Michael Wilfley, both being applications assigned to the assignee of this invention and incorporated by reference herein.

Background and Field of Invention

This invention relates to centrifugal clutches and more particularly relates to a novel and improved centrifugal clutch which is capable of manual and automatic control of the maximum pressure exerted on the clutch plates when moved into the engaged position as well as the amount of pressure required to disengage the clutch plates.

We have previously devised centrifugal clutches of the type having a plurality of cam

members or balls which will move outwardly in response to rotation of a drive shaft to force a plurality of clutch plates into engagement with one another. In certain applications, such as, motorcycle clutches it is important to generate sufficient centrifugal force to clamp the clutch plates together without substantial slippage and without utilizing a larger sized case which exceeds the space allowances within a stock or standard engine case. Space is at a particular premium in motorcycle clutches incorporating a manual override mechanism, such as, set forth in hereinbefore referred to U.S. Application Serial No. 10/327,160 for MULTI-ROW CAM-ACTUATED CENTRIFUGAL CLUTCH. Further, it is desirable to incorporate into the end of the clutch case between the cover and pressure plate a pressure control mechanism which will combine the features of an automatic clutch with the performance of a traditional manual clutch so that the clutch can engage smoothly without the use of a clutch lever at low speeds but at the same time limit the axial force transmitted to the clutch plates by the cam members at higher speeds. In addition, it is highly desirable that the pressure control mechanism cooperate with the manual override lever in such a way as to minimize the hand pressure

required to override the cam members and effectively operate as a conventional manual clutch with relatively light feel or manual pressure and yet be capable of operating within the same space limitations as the standard or stock motorcycle clutches.

Summary of the Invention

It is therefore an object of the present invention to provide for a novel and improved clutch of a type which is capable of controlling the maximum pressure exerted on the clutch elements while assuring non-slipping clutch engagement up to a predetermined force or pressure level as well as being manually controllable to disengage independently of the pressure control mechanism.

It is another object of the present invention to provide, in a centrifugal clutch of the type having an internal manual disengagement mechanism, for an automatic pressure control mechanism which will limit the maximum pressure to which the clutch elements can be subjected and without expanding the size of clutch housing required.

A further object of the present invention is to provide, in a motorcycle clutch, for non-slipping engagement under normal operating

conditions while limiting the maximum pressure to which the clutch elements can be subjected in order to permit controlled slippage of the clutch elements when subjected to shock loads imparted through the drive train of the vehicle on which the clutch is mounted.

It is a still further object of the present invention to provide in a motorcycle clutch for a maximum pressure spring control mechanism of the type employing multiple, circumferentially spaced springs between a cover and retainer plate for the centrifugal clutch-actuating mechanism to limit the maximum amount of pressure applied to the clutch members and to mount same within a standard or stock motorcycle case.

The present invention resides in a centrifugal clutch of the type having a plurality of cam members or balls interposed between a cover and pressure plate, the cam members being movable radially outwardly under centrifugal force to cause the pressure plate to move in a direction forcing the clutch members into clutching engagement, the improvement comprising cam retainer means between the pressure plate and cover for retaining the cam members in one or more concentric rows whereby to guide inward and outward radial movement of the cam

members, first fastener means for maintaining a predetermined spacing between the cover and the retainer means, second fastener means for maintaining a predetermined spacing between the pressure plate and retainer means including means resiliently biasing the pressure plate and retainer means toward one another, and a series of circumferentially spaced resilient biasing members interposed between the cover and retainer means and wherein the resilient biasing members are operative to undergo compression in response to continued radially outward movement of the cam members once the force exerted on the friction plates equals the force exerted by the resilient biasing members on the pressure plate and retainer means.

There has been outlined, rather broadly, the more important features of the invention in order that the detailed description thereof that follows may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional features of the invention that will be described hereinafter and which will form the subject matter of the claims appended hereto. In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the

invention is not limited in its application to the details of construction and to the arrangements of the components set forth in the following description. The invention is capable of other embodiments and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein are for the purpose of description and should not be regarded as limiting. As such, those skilled in the art will appreciate that the conception, upon which this disclosure is based, may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

Brief Description of the Drawings

Figure 1 is a view partially in section of a centrifugal clutch for a motorcycle and illustrating the clutch in a disengaged position;

Figure 1A is a view in more detail of the maximum pressure wave springs employed in accordance with the present invention;

Figure 2 is a view similar to Figure 1 but

illustrating the clutch in an engaged position;

Figure 3 is a view similar to Figures 1 and 2 illustrating the clutch engaged at maximum force;

Figure 4 is a view similar to Figures 1 to 3 but illustrating the clutch disengaged by a manual override mechanism;

Figure 5 is an exploded view of the major elements of the clutch shown in Figures 1 to 4;

Figure 6 is an end view of a stationary cover portion of the clutch shown in Figures 1 to 5;

Figure 7 is a cross-sectional view taken about lines 7-7 of Figure 6 and of Figure 8;

Figure 8 is an opposite end view to that of Figure 6;

Figure 9 is an end view of a movable cover portion for the clutch of Figures 1 to 5;

Figure 10 is a cross-sectional view taken about lines 10-10 of Figure 9;

Figure 11 is an opposite end view to that of Figure 9;

Figure 12 is a cross-sectional view taken about lines 12-12 of Figures 9 and 11;

Figure 13 is an end view of a pressure plate employed in the clutch of Figures 1 to 5;

Figure 14 is a cross-sectional view taken

about lines 14-14 of Figures 13 and 15;

Figure 14A is a cross-sectional view taken about line 14A of Figure 15;

Figure 15 is an opposite end view of the cover shown in Figure 13; and

Figure 16 is a view partially in section of a modified form of clutch in accordance with the present invention.

Detailed Description of One Form of Invention

Referring to the drawings, there is shown by way of illustrative example in Figures 1 to 14A a representative form of clutch 10 which is specifically adaptable for use in a motorcycle, not shown. In the standard motorcycle, a crankshaft from an engine imparts rotation to a power input side of the clutch through a shaft or pinion or a chain or other means. In the case shown, a chain is used to impart rotation to drive sprocket 13 on clutch housing 14. A transmission shaft 16 is mounted for rotation by a hub 26 when clutch plates 22 and 24 are engaged; and through a transmission, not shown, is operative to rotate a belt or chain drive, not shown, to the rear wheel of the motorcycle. A starter gear 12 can receive input power from a starter, not shown, to rotate the housing 14 and drive sprocket 13 which in turn

rotates the crankshaft to start the engine. As illustrated in Figure 1, a control rod 18 extends through the transmission shaft 16 and is manually controlled by a hand lever L typically mounted on the handlebar of the motorcycle and operates through a control cable C to force a threadedly adjustable stem 20 forwardly to disengage the clutch plates 22 and 24 between the outer housing 14 and hub 26, respectively.

As best seen from Figures 1 to 15, a cam-actuating mechanism 28 is mounted between a pressure plate 30 and a cover 32. The cover 32 comprises an annular stationary wall portion 34 having an outer peripheral edge 35 affixed to the housing 14 by suitable fasteners 36. In addition, the cover 32 includes an inner movable cover portion 38 made up of a relatively thick inner wall portion 39 and an outer relatively thin annular retainer portion 40 which extends directly behind the annular cover portion 34.

The cam-actuating mechanism 28 is comprised of radially inner and outer rows of circumferentially spaced cam members or balls 42 and 44 interposed between the pressure plate 30 and the retainer portion 40. The balls 42 and 44 are responsive to centrifugal force to roll outwardly

along radial pockets or cam faces 46 and 48 in the pressure plate 30, shown in Figures 13 to 15, and aligned pockets or cam faces 50 and 52 in the retainer portion 40 of the cover 38, as shown in Figures 9 to 12, so as to cause the pressure plate 30 to axially displace the outer frictional clutch plates 22 into locking engagement with the inner clutch plates 24. The cam-actuating mechanism 28 is modified somewhat from that of hereinbefore referred to copending application for patent for MULTI-ROW CAM-ACTUATED CENTRIFUGAL CLUTCH by utilizing only one row of cam faces 46 and 50 in inner, staggered concentric relation to the outer row of cam faces 48 and 52, respectively, in the pressure plate 30 and cover portion 40. Nevertheless, it will be apparent that a third row of confronting cam faces in the pressure plate 30 and cover portion 40 may be utilized for a set of smaller balls, as shown and described in my hereinbefore referred to copending application for patent for MULTI-ROW CAM-ACTUATING CENTRIFUGAL CLUTCH to generate increased clamping force between the clutch plates 22 and 24.

In accordance with the present invention, the cam faces 50 and 52 are in the form of pockets of generally oval-shaped configuration indented in a flat surface of the movable cover portion 40 and

are elongated in the radial direction. Similarly, the cam faces 46 and 48 in the pressure plate 30, as best seen from Figures 14 and 15, are in the form of radial pockets of generally concave configuration elongated in a radial direction and correspond in size and configuration to the aligned cam faces 50 and 52 in the retainer portion. However, the cam faces 48 in the outer row of the pressure plate 30 each terminate in flattened surface portions 49 so as to form a stop point at the outer peripheral edge of the pressure plate 30 to limit the travel of the cam members 44. Just inwardly of the inner row of cam faces 46, a plurality of circumferentially spaced counterbores 54 are aligned with bores 56 in the cover portion 38, the bores 56 being adapted for insertion of threaded fasteners in the form of shoulder bolts 58 between the cover portions 38 and 32 while leaving a predetermined spacing or clearance 60 between the cover portions for a purpose to be hereinafter described. It will be noted that the cover portion 38 is axially displaceable with respect to the threaded fasteners in the form of shoulder bolts 58 so as to move through the clearance space 60 in response to increased spreading forces applied by the balls 42 and 44 after the clutch plates 22 and 24 have moved

into clutching engagement as will be later described with reference to Figure 3.

A second series of circumferentially spaced bores 62 are formed in the cover 38 in the raised or center portion 39 of the cover 38 and are adapted to receive tubular posts 63 extending from the pressure plate 30 for insertion of threaded fasteners in the form of bolts 64. A spring retainer in the form of a washer 65 having an annular shoulder 66 is positioned at one end of each tubular post 63 to receive each bolt 64. The wall of each bore 62 is provided with an annular shoulder 68 in opposed facing relation to the external shoulder 66 so that the shoulders 66 and 68 define end stops for a spring 70 which is mounted under compression therebetween. The springs 70 pre-load the balls 42 and 44 under a predetermined amount of force to resist outward radial movement of the balls 42 and 44 until the engine reaches a predetermined speed imparting a sufficient degree of centrifugal force to the balls 42 and 44 to advance outwardly along their respective cam faces. The pre-compression or pre-loading of the springs 70 can be adjusted by shims 71 as well as the inward threading of each bolt 64 to vary the distance between the shoulders 66 and 68. Preferably, the springs 70 are

SPIRAWAVE® wave springs which are flat wire compression springs, Model No. C075 manufactured and sold by Smalley Steel Ring Co. of Lake Zurich, Illinois.

A series of maximum pressure spring pairs 72, 72A are mounted between counterbored seats 74 in circumferentially spaced relation to one another around the outer periphery of the cover portion 40 and aligned bores or spring seats 75 in the confronting surface of the cover 32. Preferably, the spring pairs 72, 72A are made up of inner and outer concentric SPIRAWAVE® wave springs as illustrated in the detail view of Figure 1A which in unison will be compressed as the pressure plate 30 and cover portion 40 are expanded to move the clutch plates 22 and 24 into engagement, as shown in Figure 2, until the clamping force exerted on the clutch plates 22 and 24 equals the resisting force exerted by the springs 72, 72A. Further, the clearance space 60 between the cover portions 32 and 40 will move into engagement before the springs 72, 72A are compressed beyond their usable travel which is the amount of deflection without permanent deformation of the springs 72, 72A.

An important characteristic of the SPIRAWAVE® wave springs 72 and 72A is their greatly reduced height or travel for a given amount of

resistance as compared to standard coil springs and therefore occupy much less space in an axial direction. In this way, the cam-actuating mechanism 28 together with the spring force-limiting mechanism as described will fit into existing clutch housings, such as, the twin cam 88 of Harley-Davidson Motor Company of Milwaukee, Wisconsin and other makes of motorcycles. The spring force of the springs 72, 72A is such as to resist opening or spreading of the pressure plate 30 and cover portion 40 beyond a predetermined limit. That limit is the maximum clamping force that can be safely exerted on the clutch plates 22 and 24 to assure non-slipping engagement under normal operating conditions but which will permit the clutch plates 22 and 24 to slip in the event that extreme shock loads are transmitted through the drive train. For example, the clutch plates will permit slight or instantaneous slippage so as to absorb any shock loading when the rear wheel of the motorcycle is off the ground and spinning then suddenly hits the ground and is stopped while the engine continues to run. When extreme clamping forces of that nature are applied, the cam-actuating mechanism 28 will overcome the force or bias of the springs 72, 72A to shift away from the clutch plates 22 and 24, as best seen from Figure 4, through the

clearance space 60. This enables limited movement of the entire cam-actuating mechanism 28 away from the clutch plates 22 and 24 until the cover portion 40 abuts the cover portion 34.

Sufficient clearance is provided, also, between the clutch plates 22 and 24 and pressure plate 30 as generally designated at 61 to adjust for any wear in the clutch plates 22 and 24. For example, as the clutch plates 22 and 24 undergo wear, they will create a greater clearance space 61, but the cam-actuating mechanism is capable of undergoing greater spreading before the maximum pressure springs 72, 72A will exert a counteracting force on the cam-actuating mechanism 28.

Figure 1 illustrates the clutch 10 at rest or operating at low speeds with the clutch plates 22 and 24 therefore disengaged. As engine speed increases, the balls 42 and 44 will advance radially outwardly to force the pressure plate 30 toward the clutch plates 22 and 24 and simultaneously urge the cover portion 40 in the opposite direction against the resistance of the springs 72, 72A until the resistance of the clutch plates equals that of the springs 72, 72A, for example, as illustrated in Figure 2.

As illustrated in Figure 3, as the balls 42

and 44 continue to move outwardly under increasing speeds, the cover portion 40 will continue to advance axially against the springs 72, 72A so that no increased force is applied to the clutch plates, and the balls 42 and 44 will have reached the limit of the ball pockets, as illustrated in Figure 3. A notable advantage of utilizing concentric wave springs 72, 72A of the type described is that the stationary cover 32 retains sufficient strength to avoid expansion or buckling of the cover 32 when maximum forces are applied to the springs 72, 72A. In addition, the spring force can be adjusted by selecting the number of springs 72 to be inserted between the pressure plate 30 and cover portion 40. For example, a spring 72 may be positioned in every other spring seat 75. Correspondingly, the number of inner springs 72A may be varied but preferably are used only in combination with an outer spring 72. Further, the amount or degree of pre-loading force of resistance of the springs 70 can be fine-tuned or adjusted by the utilization or one or more shims 71.

There are certain conditions under which it is desirable to be able to control the clutch manually and to override the automatic clutch. As illustrated in Figures 1 to 4, the push rod 18 extends through the transmission shaft 16 from the

manual control lever L which operates the push rod 18 through the control cable C as shown in Figure 1. A leading end 76 of the push rod is aligned with a trailing end 78 of the threadedly adjustable stem 20, and the stem 20 threadedly engages a disk 79 having an outer peripheral edge which is fixed to an inner wall 80 of the pressure plate 30 by a snap ring 82. A lock nut 84 is threaded onto the stem 20 to fix the axial disposition or relationship of the stem 20 to the push rod 18 and control the distance of travel of the pressure plate 30 in response to actuation of the push rod 18. Accordingly, when the push rod 18 is actuated by the control lever, it will cause the entire cam-actuating mechanism 28 to be displaced away from the clutch plates 22 and 24, as illustrated in Figure 4. At low speeds, engaging the push rod 18 will cause the pressure plate 30 to be held away from the clutch plates 22 and 24. This requires no or minor compression of the springs 70 so that the physical effort required to hold the pressure plate is minimal. At high speeds, the push rod 18 can still be engaged to release the clutch but have to move the entire cam-actuating mechanism 28 as an assembly away from the clutch plates 22 and 24 by compressing the springs 72, 72A. This requires a greater physical force than at low speeds but never

more than the force exerted by the springs 72, 72A.

The following are representative of different situations in which it is desirable to manually disengage the clutch:

1. Manually disengage at start of a race and rev up the engine to create a sufficiently high torque that a fast start can be initiated.

2. In traversing a curve or corner, to disengage the clutch to cut speed but rev up the engine and engage it to accelerate quickly.

3. When starting the engine with transmission in gear, manually disengage the clutch to keep the motorcycle at rest.

4. In climbing a hill, slipping the clutch manually makes it easier to generate higher engine speed in order to get more power to get up the hill.

5. To lift the front wheel over an obstacle, manually disengage the clutch, increase engine speed and re-engage the clutch for rapid acceleration.

As shown in Figure 3, when the speed is reduced below that required to move the clutch plates 22 and 24 into engagement, the springs 70 will rapidly force the balls 42, 44 to move inwardly and permit the pressure plate 30 to retract away from the clutch plates 22, 24 and return to the position shown

in Figure 1.

It will be evident that other spring types may be utilized in place of the SPIRAWAVE® wave springs 70 depending upon the spring force required to counteract the centrifugal force of the cam-actuating mechanism 28 as well as the space available for a given amount of counteracting spring force required. Other factors to be considered are the amount of torque that the clutch is required to transmit, the size of the clutch plates 22 and 24, and the hand pressure required to disengage the clutch manually. Accordingly, other types of springs may be utilized, such as, coil springs and Belleville washer springs, the latter extending through a circumferential groove in the inner surface of the cover; however, for a given size or thickness of cover will be substantially weakened by a continuous circumferential groove, and a continuous spring element ordinarily will not achieve the same spring force for a given distance of travel.

Modified Form of Invention

A modified form of invention is illustrated in Figure 16 in which like parts are correspondingly enumerated to the preferred form of Figures 1 to 15. When employed in a motorcycle, a chain imparts rotation to drive sprocket 96 on clutch

housing 97. A transmission shaft 101 is mounted for rotation by hub 102 when the clutch plates 22 and 24 are engaged; and through a transmission, not shown, is operative to rotate a belt or chain drive, not shown, to the rear wheel of the motorcycle. A starter gear 95 is operative to rotate the housing 97 and the drive sprocket 96 which in turn rotates a crankshaft to start the engine. A pull rod or stem 98 is used in place of the push rod 18 and threaded stem 20 of the preferred form to manually disengage the clutch. Thus, the stem 98 is journaled to the cover portion 94 by a ball bearing assembly 99 which is mounted in the center of the pressure plate 100. The stem or control rod 98 may be directly controlled by a hand lever, not shown, in the same manner as the lever L of Figure 1.

Both with respect to the preferred and modified forms of invention, it will be appreciated that they are readily conformable for use in other applications than motorcycles and are adaptable for use in any application which employs an internal combustion engine, such as, for instance drag racing, cars, trucks, tractors, go-carts, cement mixers, all terrain vehicles, power tools including but not limited to chain saws and weed eaters and virtually any application in which an automatic clutch can be

utilized.

It is therefore to be understood that while preferred and modified forms of invention are herein set forth and described, the above and other modifications may be made therein without departing from the spirit and scope of the invention as defined by the appended claims and reasonable equivalents thereof.